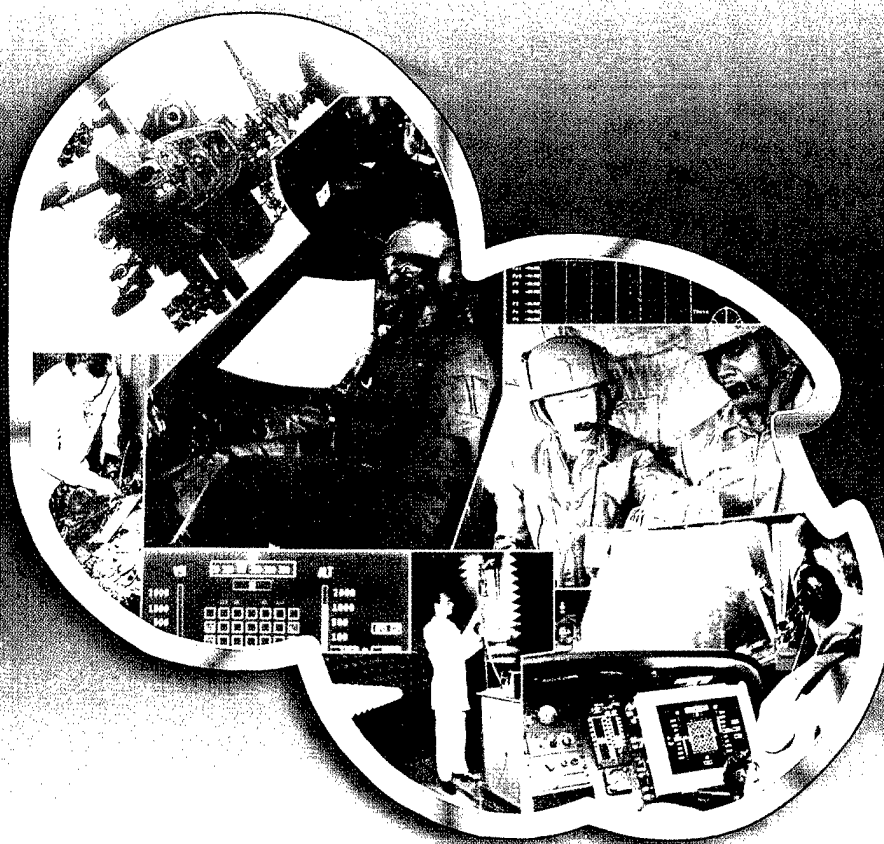


USAARL Report No. 2001-03

Is Fatigue a Problem in Army Aviation? The Results of a Survey of Aviators and Aircrews

by

John A. Caldwell, Stephen R. Gilreath, Bradley S. Erickson, and
Nicholas K. Smythe



Aircrew Health and Performance Division

December 2000

Approved for public release, distribution unlimited.

20010216 019

U.S. Army
Aeromedical Research
Laboratory

U
S
A
A
R
L

Notice

Qualified requesters

Qualified requesters may obtain copies from the Defense Technical Information Center (DTIC), Cameron Station, Alexandria, Virginia 22314. Orders will be expedited if placed through the librarian or other person designated to request documents from DTIC.

Change of address

Organizations receiving reports from the U.S. Army Aeromedical Research Laboratory on automatic mailing lists should confirm correct address when corresponding about laboratory reports.

Disposition

Destroy this document when it is no longer needed. Do not return it to the originator.

Disclaimer

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citation of trade names in this report does not constitute an official Department of the Army endorsement or approval of the use of such commercial items.

Human use

Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRMC Reg 70-25 on Use of Volunteers in Research.

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
1a. REPORT SECURITY CLASSIFICATION Unclassified			1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION			3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release, distribution unlimited		
2b. DECLASSIFICATION / DOWNGRADING					
4. PERFORMING ORGANIZATION REPORT NUMBER(S) USAARL Report No. 2001-03			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION U.S. Army Aeromedical Research Laboratory		6b. OFFICE SYMBOL (If MCMR-UAD	7a. NAME OF MONITORING ORGANIZATION U.S. Army Medical Research and Materiel Command		
6c. ADDRESS (City, State, and ZIP Code) P.O. Box 620577 Fort Rucker, AL 36362-0577			7b. ADDRESS (City, State, and ZIP Code) 504 Scott Street Frederick, MD 21702-5012		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c. ADDRESS (City, State, and ZIP Code)			10. SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO. 622787	PROJECT NO. 879	TASK NO. X
11. TITLE (Include Security Classification) (U) Is Fatigue a Problem in Army Aviation? The Results of a Survey of Aviators and Aircrews					
12. PERSONAL AUTHOR(S) J. Caldwell, S. Gilreath, B. Erickson, N. Smythe					
13a. TYPE OF REPORT Final		13b. TIME COVERED FROM TO		14. DATE OF REPORT (Year, Month, 2000 December	
15. PAGE COUNT 18					
16. SUPPLEMENTAL NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) survey, aviation, fatigue, sleep, flight safety		
FIELD	GROUP	SUB-GROUP			
05	09				
01	02				
19. ABSTRACT (Continue on reverse if necessary and identify by block number) Recently published data on military aviation mishaps suggest aircrew fatigue remains a flight safety problem. The current study, in which the responses from 241 Army aviators and 120 Army enlisted crew members were analyzed, indicates that inadequate sleep and/or insufficient sleep quality is adversely affecting on-the-job alertness. The requirements to work a variety of schedules and to travel/work away from home are likely contributing to less than optimal sleep quality; however, a number of personnel may be suffering from sleep deprivation due to intentional sleep restriction as well. The personnel surveyed in this study indicated they were sleeping less than 7 hours per night which is 1 hour less than the amount recommended by sleep specialists. This insufficient sleep, combined with rotating schedules and other work demands, no doubt contributed to the perceptions of three-quarters of the present sample that fatigue is a widespread problem in the military aviation community. These results indicate the importance of continuing to stress fatigue-reduction strategies in training and operational environments.					
20. DISTRIBUTION / AVAILABILITY OF <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a. NAME OF RESPONSIBLE INDIVIDUAL Chief, Science Support Center			22b. TELEPHONE (Include Area (334) 255-6907		22c. OFFICE SYMBOL MCMR-UAX-SI

Table of contents

	<u>Page</u>
Military relevance	1
Background	1
Objective	2
Methods	3
Subjects	3
Apparatus	3
Procedure	4
Data analysis	4
Results	5
Basic descriptive information	5
Working/flying hours and work schedules	6
Sleep hours and sleep schedules	8
Alertness/sleepiness on the job and in the flight environment	10
Discussion	12
References	16

List of tables

1. Responses to basic descriptive information.	5
2. Responses to working/flying-hour questions.	6
3. Responses to questions about sleep times and hours.	9

List of figures

1. Percentage of responses made by pilots and nonpilots regarding the time of day at which most flights occur	7
--	---

Table of contents (continued)

Page

List of figures (continued)

2. Percentage of responses made by pilots and nonpilots about the time of day at which most of their work is performed	7
3. Percentage of responses from pilots and nonpilots regarding the consistency of their work/rest schedules	8
4. Percentage of pilots and nonpilots who characterized their sleep quality as excellent, good, fair, or poor while at home	10
5. The percentages of pilots and nonpilots who rated their sleep quality as excellent, good, fair, or poor while TDY/deployed	10
6. The percentage of pilots and nonpilots who reported having flown when they could have easily gone to sleep	11
7. The percentage of pilots and nonpilots who stated that they had at some point actually dozed off while flying/in the cockpit	12
8. The percentage of pilots and nonpilots who thought fatigue was a widespread problem in military aviation	12

Military relevance

Recent aviation mishaps have focused considerable attention on the adverse impact of fatigue on flight safety, particularly within the commercial aviation community. However, data from the Air Force, Navy, and Army safety centers suggest that aircrew fatigue remains a significant problem in military aviation as well. Throughout both aviation communities, countermeasures such as crew-endurance guidelines and educational programs have been implemented to address the problem, but the effectiveness of these measures from the point of view of the aviators and their crews has not been adequately assessed, especially in the military. The current study was conducted to determine whether fatigue is currently an issue of concern within the Army aviation community. The results may offer insight into the adequacy of existing fatigue-countermeasures and may also suggest future strategies for ensuring a high level of alertness in the cockpit.

Background

The issue of aviator fatigue has recently received significant attention due to media coverage of commercial accidents. For instance, in November 1999, the National Transportation Safety Board (NTSB) ruled that fatigue was responsible for the general confusion and impaired reactions that lead to the crash of Korean Air flight 801 at Guam International Airport in August 1997 (Hebert, 1999). The recovered cockpit voice recorder revealed that the captain was "really . . . sleepy," and there was evidence that the aircrew became unnecessarily distracted by an inoperable glide slope on the instrument landing system (NTSB, 1997). This accident resulted in the deaths of 228 people. The more recent crash of American Airlines flight 1420 (in which 11 people died) also is being at least partially attributed to pilot fatigue (Krause, 1999). Although the NTSB has yet to make a final ruling, a 1999 hearing by the House Subcommittee on Aviation indicated that pilot fatigue was the focus of the investigation (Committee on Transportation and Infrastructure, 1999). Fatigue has been cited in other aviation mishaps as well, such as the 1985 near-crash of a China Airlines Boeing 747 (flight 006) and the DC-8 accident at Guantanamo Cuba Naval Base (Battelle Memorial Institute, 1998).

The fact that aircrew fatigue warrants concern in the aviation community stems not only from case studies of commercial accidents such as these, but from military sources as well. Ramsey and McGlohn (1997) reported that 25% of the Air Force's night tactical fighter Class A accidents were attributable to fatigue between 1974 and 1992, and 12.2% of the Navy's total Class A mishaps were a result of aircrew fatigue from 1977 to 1990. Furthermore, statistics from the U.S. Army Safety Center indicate that 4% of the Army's total mishaps (Class A, B, and C) from 1990 to 1999 were fatigue related (Army Safety Center, 2000).

Both the military and the civilian aviation sectors are concerned about these statistics, and as a result, fairly detailed crew work/rest guidelines have been implemented. For civilian operations, domestic commercial carriers are basically required to limit total crewmember flying

time to 30 hours for each 7-day period and to ensure rest breaks lasting from 9 to 11 hours (depending on the length of the upcoming flight) within 24 hours prior to the completion of a flight segment (Federal Aviation Regulations, 2000). A maximum of 100 hours of flight time is permitted per month, with a maximum of 1,000 hours per year. For Army aviation operations, the basic recommendation is that aviators fly no more than 37 hours in each 7-day period, and that a minimum of 8 hours of rest be provided within each 24-hour duty period. A maximum of 140 hours per month is permitted during periods of mobilization, with only 90 hours authorized during peace time (Department of the Army, 1997).

In addition to these flight-time limitations, the U.S. government has made a considerable effort towards managing fatigue through research and education. In fact, the National Aeronautics and Space Administration (NASA) Ames Fatigue Countermeasures program was formed in 1980 specifically to determine the overall impact of fatigue on aviation safety and to develop solutions for the fatigue problem (NASA, 2000). This program has raised awareness of pilot fatigue and produced a fatigue-management training course which is attended by airline pilots from around the world. In addition, NASA has lead the way in formulating new guidelines for work/rest scheduling in commercial aviation (Dinges et al., 1996), but these have not yet been implemented by the Federal Aviation Administration. In the military arena, all three services (Army, Navy, and Air Force) include education on fatigue as an integral part of aviator training; track the occurrence of fatigue-related problems throughout all of their aviation units; and conduct research on fatigue countermeasures for air operations. Thus, the issue is receiving significant attention in both the civilian and military communities.

Unfortunately, there are indications that more work remains to be done. A report by Ritter (1993) indicated that fatigue from sleep deprivation, circadian disruptions, and other factors is a major contributor to the cognitive and judgement errors made by aircrews. Also, a recent survey of corporate/executive pilots, who routinely deal with "unscheduled flights, quickly changing schedules, and extended duty periods," revealed that fatigue was a common problem for 61% of the respondents. Furthermore, a large majority (85%) stated fatigue was a moderate or severe safety issue, and nearly 75% of the group indicated that they had at one time or another "nodded off" in the cockpit during flights (Rosekind et al., 1997). Taken together, these results suggest fatigue remains a significant problem for civilian pilots. The extent of similar problems in the military is unknown; however, the fact that Army (and other military) pilots routinely work a variety of different schedules and rapidly deploy across different time zones (Caldwell and Cornum, 1992; Comperatore et al., 1996), makes it likely that aircrew fatigue remains an issue for the military as well.

Objective

In order to assess whether fatigue is an issue of concern within the Army aviation community, a brief survey was designed to acquire information about aviator work hours, flight time, sleep/rest adequacy and quality, and perceptions about fatigue and its impact on air safety.

The present report highlights the results of this survey and indicates that fatigue-reduction strategies should remain an important component of the Army's safety program for aviators and their crews.

Methods

Subjects

A total of 401 Army aviators and aircrew members completed and returned the surveys described in this report. These personnel were assigned to units at Fort Rucker, Alabama; Fort Bragg, North Carolina; Fort Campbell, Kentucky; and Fort Lewis, Washington. In addition, 40 of the respondents were members of the North Dakota National Guard, and a few participants were aviators who had reported to the U. S. Army Aeromedical Research Laboratory (USAARL), Fort Rucker, to participate in other research activities. The specific Army posts were selected in an effort to gather representative data from a mixture of aviators who were performing support, training, and actual "go-to-war" missions. The choice of units to be surveyed from each post depended on time and availability since it was necessary to schedule this research activity around operational mission and/or training requirements.

Of the 401 total surveys, 40 were dropped because the respondents were National Guard personnel (as noted above). Originally it was hoped that a larger percentage of the overall sample would consist of Guard members or Reservists; however, since this did not materialize, it was felt that the small number available probably would not be particularly representative of the Guard/Reserve subpopulation. Also, it was decided that the 40 respondents in this subpopulation should not be combined with the active Army personnel since they were not engaged in full-time military flight careers. Thus, the final sample that was analyzed excluded these individuals, leaving a total of 361 completed surveys for analysis. Of these, 241 of the surveys were completed by pilots and 120 were completed by nonpilots.

Apparatus

The survey was a locally-constructed instrument which consisted of four pages of detailed questions about sleep habits, work hours, flight hours, and fatigue levels encountered while in garrison (at the home post) and while traveling away from the home post (deployed or "out in the field"). In addition, questions were aimed at establishing whether fatigue was considered to be a significant safety concern. There were 64 questions in all, but several of the items included multiple subquestions. For instance, one of the items (the third) requested information on rank, age, and length of military service. Thus, there were actually a total of 93 possible data points (responses) from each questionnaire.

Procedure

The majority of respondents were surveyed directly by a USAARL staff member. After the unit's commander was contacted to gain permission for the survey, a member of the USAARL staff (a field-grade officer who was an aviator himself) traveled to the unit, explained the survey instrument, administered the questionnaires, and collected the responses. Participation was completely voluntary, and there were a small percentage of unit members who declined to complete a questionnaire. A subset of the questionnaires was mailed to units for distribution, and the completed surveys were retrieved via return mail. In addition, a small number of questionnaires were administered to aviators who were reporting to USAARL in order to participate in a laboratory research project. It is estimated that a total of approximately 450 surveys were distributed, but an exact count was not possible since single copies distributed via e-mail may have been duplicated an unknown number of times, and these may or may not have been completed (as promised, no individual or unit identifiers were attached to the questionnaires). However, because of the manner in which the survey was conducted (i.e., gaining prior permission to survey a unit, explaining the instrument face-to-face, and usually waiting on site to collect the completed questionnaire), the response rate was extremely high.

Once the completed surveys were returned to the Laboratory, they were entered into USAARL's main computer twice—one time for initial data recording, and a second time for verification of correct data entry. If a response to a specific item was unclear and could not be clarified based on the answer(s) to another question, the item was left blank and considered to represent missing data. For instance, there were cases in which a respondent chose more than one of the stated alternatives in response to a multiple-choice question that should only have had one answer. In this case, the item was left blank in the final data file.

Data analysis

Only a subset of the survey items is included in the present report because many of the questions were designed more for tailoring new research studies to precise Army needs rather than for yielding data on the prevalence of the problem of fatigue per se. To analyze this subset of items, which consisted mainly of categorical variables, the primary statistical tool was BMDP4F, Frequency Tables (Brown, 1990). Also, BMDP7D, One- and Two-way Analysis of Variance with Data Screening (Dixon, Sampson, and Mundle, 1990) and BMDP2D, Detailed Data Description Including Frequencies (Engelman, 1990) was used to analyze the few variables that were continuous in nature. Since the focus of the survey was simply to describe the basic schedules and amounts that aviators and crew members work, their perceptions of their own sleep amounts and quality, their on-the-job alertness, and their perceptions regarding the magnitude of problems relating to fatigue in the Army aviation environment, only cell counts (with percentages) and means were considered important as opposed to inferential statistical tests.

Results

The following sections detail the average responses to each questionnaire item. In some cases, the percentages may be slightly higher or lower than 100 due to rounding. Also, the percentages of responses in some cases were slightly influenced by the fact that some of the participants chose not to answer a specific question (thus, a percentage was categorized as "missing or no answer"). In cases where this "missing-answer" percentage was greater than 1-2 percent, this fact is noted in the text.

Basic descriptive information

The sample demographic characteristics were derived from the first few questionnaire items. These items revealed that the sample consisted of 120 enlisted service members, 158 warrant officers, and 83 commissioned officers. The enlisted personnel were primarily crew chiefs (88 percent), but some were instructors or standardization instructors for other enlisted crew members (12 percent). The warrant officers principally were "basic" pilots (57 percent), but many indicated they were either instructor pilots (25 percent), unit trainers (6 percent), or maintenance test pilots (13 percent). Approximately 98 percent of the commissioned officers said they were pilots, with only about 2 percent stating that they were either unit trainers or maintenance test pilots. For this report, all of these various job categories were collapsed into a new category in which there are only 2 dimensions: pilots and nonpilots. All of the responses to subsequent survey items were classified based on this pilot/nonpilot categorization.

The average age of the pilots was 32 years (with a range of 23-48 years), and the average age of the nonpilots was 27 years (with a range of 18-45 years). The average number of years that each group had spent in the military was 11 for the pilots and 7 for the nonpilots. The average number of total flight hours possessed by the pilots was 1158 (with a range of 95-6300 hours), and the average number possessed by the nonpilots was 581 (with a range of 0-3000). This minimum value of 0 flight hours in the nonpilot group was due to the fact that 3 nonpilot respondents apparently had been assigned to aviation units, but had not yet flown (their time in the military was .75, .92, and 1.33 years, respectively) See Table 1.

Table 1.
Responses to basic descriptive information.

Questionnaire item	Pilots	Nonpilots
Average age (in years)	32	27
Average years in military	11	7
Average total flight hours	1158	581

Working/flying hours and work schedules

To gain insight into the workload of the surveyed personnel, they were asked several questions, the results of which are included in table 2. The first two dealt with weekly work and flight hours. Specifically, they were asked "In a typical week, about how many hours do you fly?" and "In a typical week, about how many hours do you work (including commute time)?" Responses to the first question revealed that the participants in this study usually flew less than 10 hours per week. Among the pilots and nonpilots, however, there were respondents who indicated they did not fly at all during a typical week. This may have been because some of the officers were in staff positions, and some of the enlisted members were only recently assigned to an aviation unit. Responses to the second question revealed that the pilots and the nonpilots worked more than an average of 40 hours per week (including commute time). However, once again, there were some low responses in both groups (12 hours was the minimum for pilots, and 13 hours was the minimum for nonpilots). This may have been due to some confusion about the question (perhaps the respondents subtracted their flight hours from their other work hours), or in the pilot group, perhaps a few of the pilots responded with low estimates because they were presently in some type of transition course or other assignment which they did not consider "work" as it is typically defined. Evidence that there was probably some difficulty interpreting the question came from a later item which asked "On average, how many total hours per week do you work?" To this, the pilots and nonpilots indicated that they worked about the same amount of time as was gleaned from their responses to the earlier question; but here, the minimum values for both groups was 40 hours. Thus, despite these interpretive complications, it appears that both the reported average work hours and flight hours are about what might be expected of Army aviation personnel during peacetime (collapsed across pilots and nonpilots, the work hours were 65 hours per week, and the flight hours were 6.6 hours per week). When asked about the average length of a "typical flight," the participants indicated flight durations of less than 4 hours.

Table 2.
Responses to working/flying-hour questions.

Questionnaire item	Pilots	Nonpilots
In a typical week, how many hours do you fly?	5.05	8.20
In a typical week, how many hours do you work?	61.57	65.69
On average, how many total hours do you work?	62.49	66.72
Average length of a typical flight (in hours)	2.7	3.4

To determine the time of day at which most of the flights tended to occur, the sample was asked "Does the majority of your military flying occur during the day (0600-1700), evening (1400-2300), or at night (2300-0600)." In response to this question, 25 percent of the pilots stated the majority of their flights were during the day, 69 percent said their flights were during

the evening, and about 5 percent said the majority of their flights occurred at night. A similar pattern was observed within the nonpilots as can be seen in figure 1. When the overall sample was asked a similar question about the majority of their work time, 80 percent of the pilots (who were able to categorize their schedules into one of our definitions) said they worked during the day (0600-1800), 18 percent said they worked during the evening (1400-2300), and 1 percent said they worked at night (2300-0600). The responses from nonpilots were similar (see figure 2).

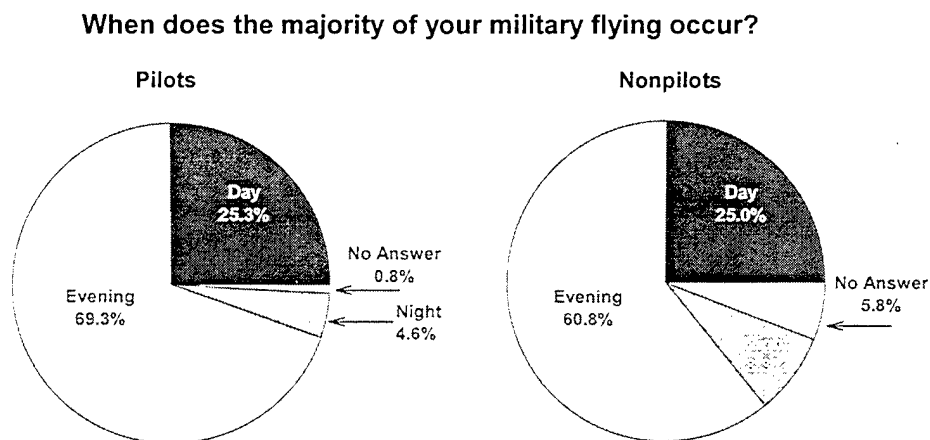


Figure 1. Percentage of responses made by pilots and nonpilots regarding the time of day at which most flights occur.

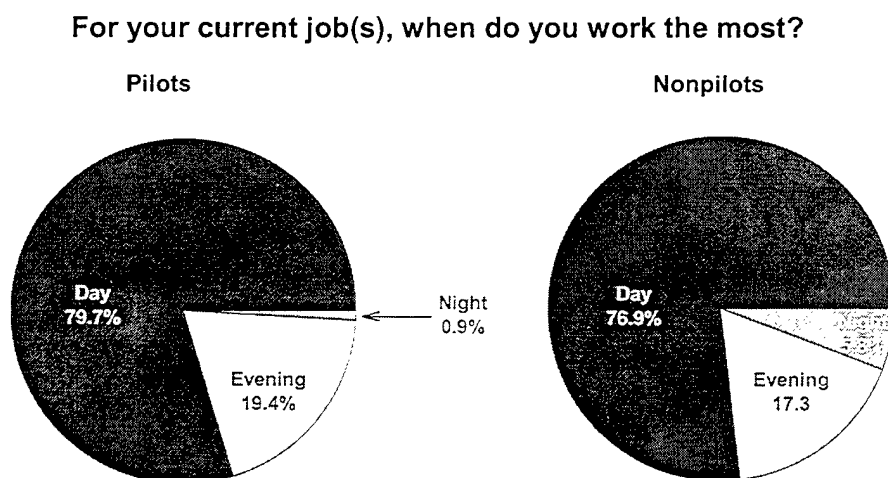


Figure 2. Percentage of responses made by pilots and nonpilots about the time of day at which most of their work is performed.

There were indications that, while most respondents were able to classify their work schedules as usually fitting into one of the categories we supplied, most of them reported working a variety of shifts. When asked "Most of the time, is your normal work and rest schedule about the same from day to day, or does it vary?" only 23 percent of the pilots and 16

percent of the nonpilots indicated they normally followed the "same" schedule. Conversely, 77 percent of the pilots and 83 percent of the nonpilots stated that their schedules normally varied. These results are presented graphically in figure 3.

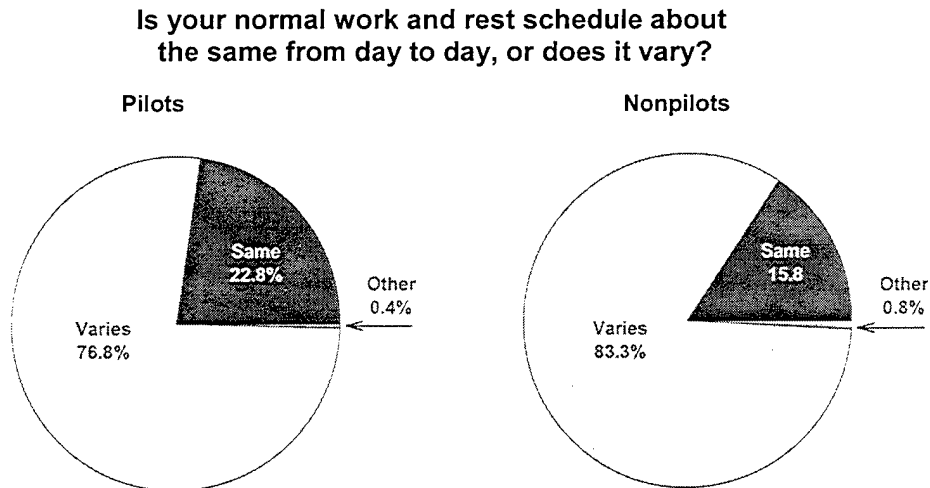


Figure 3. Percentage of responses from pilots and nonpilots regarding the consistency of their work/rest schedules.

Sleep hours and sleep schedules

Several questions were designed to determine whether the amount and quality of sleep were adequate for consistent on-the-job performance in Army aviation personnel. To start with, participants were asked about their normal bedtimes and wake-up times. Examination of the reported bedtimes revealed a bimodal distribution across the sample which was simply due to the fact that several respondents reported bedtimes later than midnight. Because of this, the mean of these data would not be the most representative summary statistic. Thus, the mode was used instead (and since the mode was used for bedtime, it was also used for the wake-up time). The most frequently reported bedtime for the pilots was 2300 and for the nonpilots it was 2200. The most frequently reported wake-up time for both groups was 0530. This suggested that most of the participants in the present survey were receiving at least 7.5 hours of sleep per night. However, this is an overestimation of the amount of nightly sleep in comparison to the mean amount that was reported by individual respondents. When they were asked "On average, how many hours do you sleep per 24-hour period?" the answers indicated that the pilots usually obtained 6.6 hours of sleep per night, and the nonpilots obtained 6.2 hours of sleep per night. (See Table 3). These sleep amounts were subsequently verified by calculating the sleep length of each participant based on his/her individually-reported bedtimes and wake-up times. These results indicated that the pilots received 6.8 hours of sleep per night and the non-pilots received about 6.4 hours of sleep per night (thus, they may have slightly underestimated their typical nightly sleep duration in response to the direct question). However, regardless of which means

considered to be the more accurate, both were still short of the amounts that the groups indicated were necessary for them to feel well-rested. The average responses to the question “How many hours of sleep do you need to feel fully rested?” revealed that the pilots thought they needed 7.5 hours, whereas the nonpilots thought they needed 7.3 hours. Therefore, the two groups were apparently feeling somewhat sleep deprived.

Table 3.
Responses to questions about sleep times and hours.

Questionnaire item	Pilots	Nonpilots
Most of the time, what time do you go to sleep?	2300	2200
Most of the time, what time do you get up from sleep?	0530	0530
On average, how many hours do you sleep? (direct)	6.6	6.2
Average hrs sleep: (calculated from sleep/wake times)	6.8	6.4

The impact of this shorter-than-desired sleep period (or sleep amount) was compounded by the fact that many of the surveyed personnel rated their sleep quality as less than optimal. In response to the question “Overall, how would you rate the quality of sleep you get at home (in garrison?)” only 18 percent of the pilots and only 3 percent of the nonpilots replied that their sleep was “excellent” (see figure 4). Among the pilots, 54 percent rated their sleep as “good,” 24 percent said their sleep was “fair,” and 4 percent stated their sleep was “poor.” Among the nonpilots, fewer subjects indicated their sleep was “good,” while more indicated their sleep was fair or poor. The ratings for both groups were substantially lower when they were asked to rate the quality of their sleep while “TDY/in the field.” Responses to this question indicated that less than 3 percent of the pilots and only 5 percent of the nonpilots rated their sleep quality as “excellent,” while 26 percent of the pilots and 36 percent of the nonpilots said their sleep quality was “poor” (see figure 5). Thus, traveling, deployments, and/or field exercises significantly reduced the subjective ratings of sleep quality in both groups.

**Overall, how would you rate the quality of sleep you get?
(In Garrison/Home)**

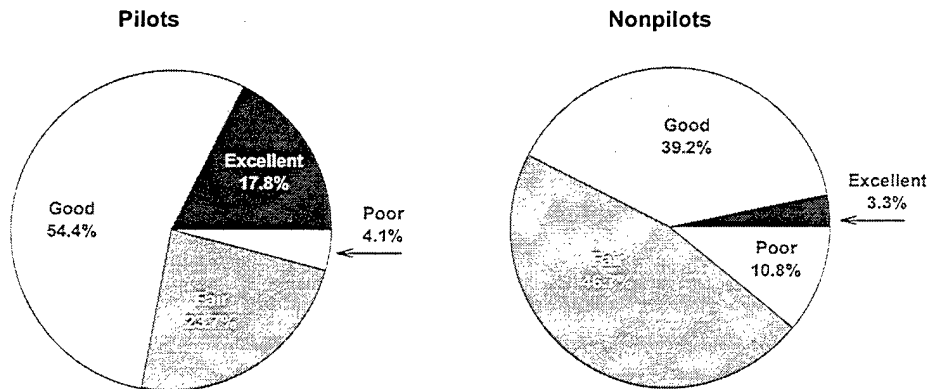


Figure 4. Percentage of pilots and nonpilots who characterized their sleep quality as excellent, good, fair, or poor while at home.

**Overall, how would you rate the quality of sleep you get?
(TDY/in the field)**

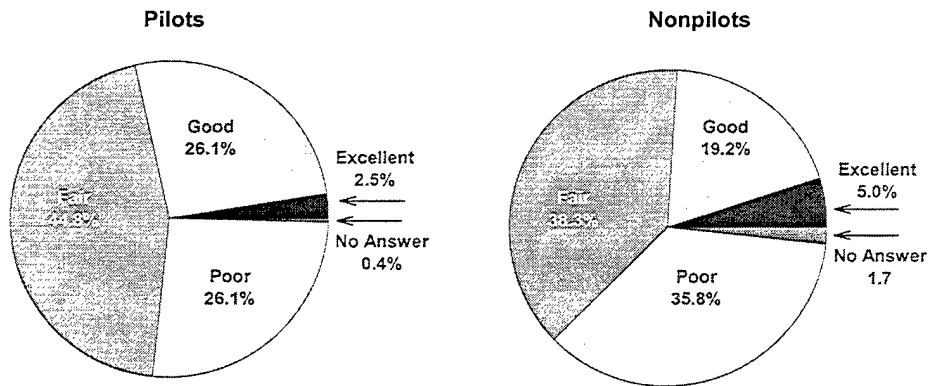


Figure 5. The percentages of pilots and nonpilots who rated their sleep quality as excellent, good, fair, or poor while TDY/deployed.

Alertness/sleepiness on the job and in the flight environment

Of all the questions asked in the current survey, the most important were those designed to assess whether sleepiness (or fatigue) should be considered a major concern in Army aviation personnel. Although several items were aimed at elucidating this issue, the most direct were six questions that were included toward the end of the questionnaire. The first of these was the question "In all the time you have been flying (military or civilian), have you ever had to fly, or have you flown, when you were so drowsy [that] you felt you could easily fall asleep?" As can be seen in figure 6, 72 percent of the pilots and 85 percent of the nonpilots answered in the

affirmative (less than 1 percent of either group left this question blank). In response to a subsequent question which asked "... have you ever dozed off while flying/in the cockpit," 45 percent of the pilots and 46 percent of the nonpilots said "yes" (8 percent of the nonpilots did not answer this question). These data are depicted in figure 7. Furthermore, 49 percent of the pilots and 25 percent of nonpilots indicated that they had at some point either cancelled or declined a mission because they felt too tired to perform safely (3 percent of the nonpilots left this item blank). Finally, 81 percent of pilots and 90 percent of nonpilots said they thought fatigue was a contributing factor to recent increases in aviation accidents/incidents; 73 percent and 87 percent (respectively) said there was a widespread problem with fatigue in the military aviation community (see figure 8); and 61 percent of the pilots and 60 percent of the nonpilots expressed the opinion that their own safety had at some point been compromised by fatigue or the lack of adequate rest.

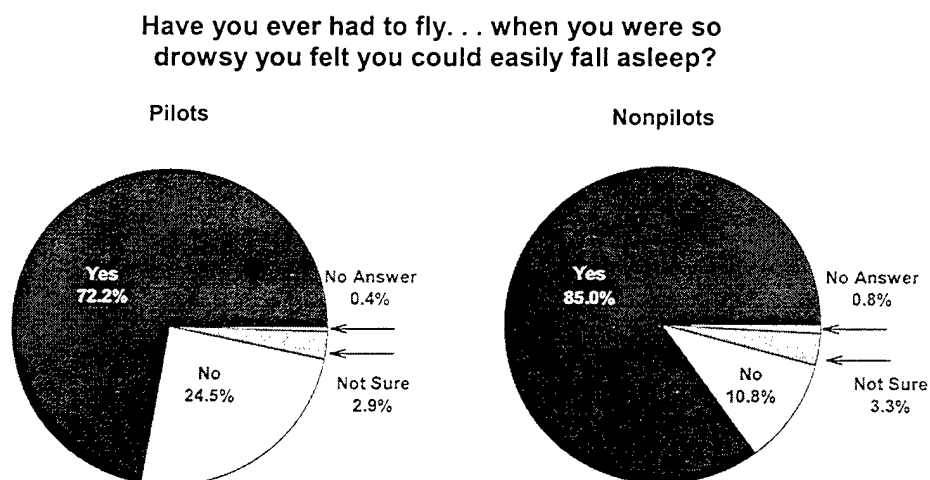


Figure 6. The percentage of pilots and nonpilots who reported having flown when they could have easily gone to sleep.

Have you ever dozed off while flying/in the cockpit,
(even if just a momentary, nonthreatening nodding off)?

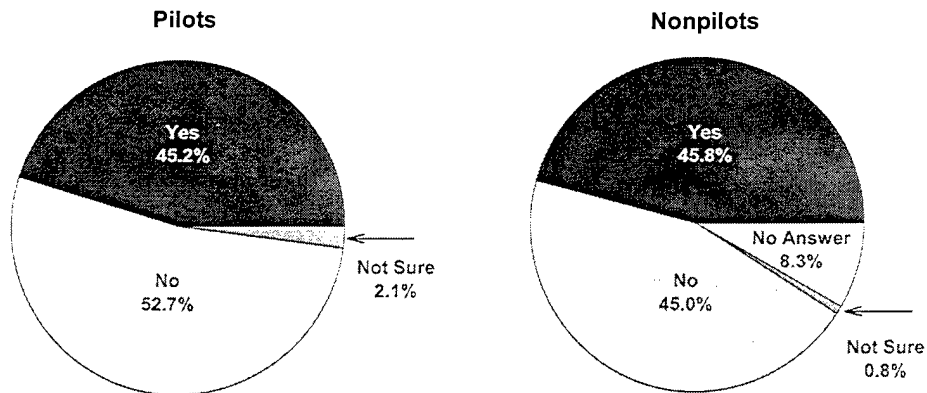


Figure 7. The percentage of pilots and nonpilots who stated that they had at some point actually dozed off while flying/in the cockpit.

Is there a widespread problem in the military aviation community
with flying, or performing other critical aviation duties, while too tired . . . ?

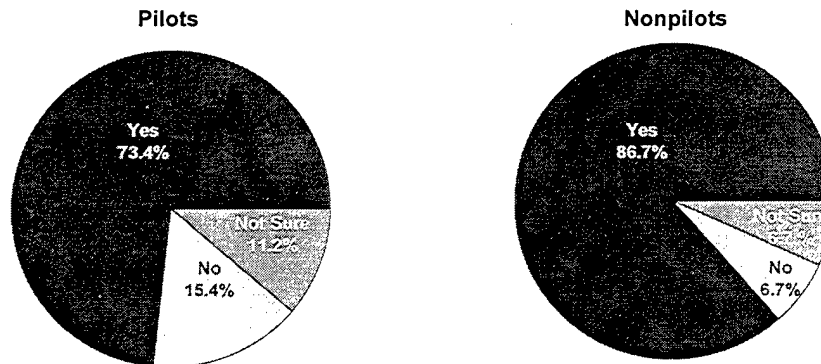


Figure 8. The percentage of pilots and nonpilots who thought fatigue was a widespread problem in military aviation.

Discussion

The present survey of 401 Army personnel, which resulted in a final analyzed sample size of 361 participants (241 aviators and 120 nonaviators), revealed previously unpublished information about the working and flying hours and schedules, the sleep hours and quality, and the prevalence of fatigue-related problems in Army aviation crews. With regard to work hours and flight hours, it appears that Army aviation crews work as much or more than other full-time

personnel in the United States. Respondents in the present sample reported working 60 or more hours per week, including commuting time, whereas the average number of work hours (not including commuting time) reported from U.S. households in the general population is 39.2 hours per week (Department of Labor, 1999). The majority of work time for our present sample was not spent in the cockpit, despite the fact that all respondents were aviators or aviation crew members. In fact, the pilots reported flying only an average of 5 hours per week while the nonpilots reported an average of about 8 hours per week. Also, the average length of a "typical flight" was estimated at 2.7 hours by the pilots and 3.4 hours by the nonpilots. One of the reasons for this large difference between "work times" and "flight times" for both groups is that a large percentage of the aviation crew member's time is spent performing administrative, training, maintenance, or some other type of duty. Another reason is that it may take many hours of preparation or "standing by" to complete a relatively short flight because military aviators and crews are affected by the same weather, maintenance, and scheduling delays that often lead to prolonged duty times (with short "flight times") in the civilian aviation sector. This issue is at the heart of current efforts to revise work/rest limitations in the civilian aviation sector (Krause, 1999), since being on duty for lengthy periods of time can produce fatigue levels similar to those produced by flying for long periods.

Another factor that can affect fatigue levels is the time of day at which work is performed. The requirement to operate during nonstandard work periods and to work a variety of different schedules can lead to impaired performance associated with cumulative sleep loss and circadian disruptions (Rosekind et al., 1994). In this regard, the present sample at first glance indicated few problems since only 5 percent of the pilots and 8 percent of the nonpilots reported that the majority of their flights occurred between 2300 and 0600. However, the issue of "fatigue associated with night shift" should not be dismissed entirely based on these results because 77 percent of the pilots and 83 percent of the nonpilots indicated that their normal work schedules varied. Thus, it is quite likely that many of the respondents engage in night flights throughout the year even though their primary work schedule falls between the hours of 0600 and 2300. This is an important consideration because it is clear that shift work seriously impacts sleep quality (and, as a result, on-the-job alertness). A 1997 survey of the general U.S. population found that 7 percent of adults considered shift work to be the main reason they experienced difficulties sleeping, and a 1999 survey revealed that the incidence of sleep problems was 13% higher in those who were able to maintain a regular sleep schedule compared to those who were not (National Sleep Foundation, 1997; 1999). Such difficulties, if ignored, can easily translate into sleepiness-related performance problems in the workplace. In fact, Dinges (1995) indicated that many of the serious incidents or accidents in industrial and transportation sectors (including aviation) have involved errors made by sleep-deprived personnel or night workers.

There were some indications from the present study that the sleep quality of respondents was not quite as high as was expected. Only 18 percent of the pilots and 3 percent of the nonpilots said their sleep while "at home/in garrison" was excellent. On the brighter side, relatively few of the participants indicated their sleep was poor (4 percent and 11 percent, respectively). These results appear to be consistent with the results obtained from surveys of the

general population. Although exactly comparable statistics are not available, these surveys suggest that 62 percent of adults experience sleep problems "a few nights a week or more" (National Sleep Foundation, 1999, p.5), while nearly half of the American workforce complained of problems with sleeplessness in recent months (National Sleep Foundation, 1997). These data indicate that our sample of aviation personnel may in fact be slightly better off than the "typical" adult concerning their sleep quality while at home. However, the picture changes when pilots and crew members are asked about their sleep while "TDY/in the field." Here, a full 26 percent of the pilots and 36 percent of the nonpilots rated their sleep quality as "poor." Thus, not surprisingly, on-the-job sleepiness is a concern of particular importance during deployments or field exercises. No doubt, sleep difficulties in these situations are the product of uncomfortable or unfamiliar sleeping conditions, circadian disruptions, and/or the increased work demands which are often associated with away-from-home operations. It should be possible to alleviate some (or many) of these concerns if proper attention is paid to optimal scheduling and ergonomic/environmental considerations (i.e., providing opportunities to sleep at appropriate times in the circadian cycle, and providing sleeping quarters that are relatively quiet and dark). In fact, several participants commented that sleep quarters for Army aviators in the field are less than optimal. Personnel are often housed in tents where day and night crews bunk together, and these tents are sometimes located in areas where noise from aircraft and personnel working nearby interfere with sleep. In addition, control of the amount of daylight entering sleeping quarters is often poor. Several respondents further indicated that appropriate crew-rest policies are not followed as closely in field settings as is the case in the home environment. Rectifying these problems will reduce the amount of sleep deprivation in field/deployment situations. As for promoting better sleep quality during normal TDY's (which may simply entail brief stays in a hotel in another city), educational efforts designed to maximize good sleep hygiene should yield substantial benefits.

In addition, an emphasis should be placed on generally educating personnel about the importance of sleep for ensuring adequate on-the-job alertness. This appears necessary based on the present sample's responses to questions about their usual amount of sleep within each 24 hour period. Based on their answers to a direct question, the average amount of sleep (per 24-hour-period) usually obtained by the aviators in the present study was 6.6 hours, whereas the average amount reported by the nonaviators was 6.2 hours. The amount of sleep deduced from the reported bedtimes and wake-up times was slightly higher, but still only 6.8 hours for the pilots and 6.4 hours for the nonpilots. These averages are slightly lower than the average obtained from a survey of the general population which indicates that U.S. adults sleep about 6 hours and 58 minutes per night during the workweek (National Sleep Foundation, 1999). This is significantly below the 8 hours of nightly sleep recommended by sleep experts, and there is evidence that this 1+ hour of chronic sleep loss can adversely affect performance. Balkin et al. (2000) recently found quantifiable decrements in daytime performance as a result of restricting sleep to a 7 hour block of time (during which subjects received an average of 6.3 hours of sleep) in comparison to a 9-hour block of time (in which subjects were able to receive 7.9 hours of sleep). The resulting alertness problems were most noticeable in a task that required a high degree of vigilance (the very quality that is of the utmost importance in aviation operations).

Thus, there should be a continuation of current efforts to educate aviators and crew members about the importance of adequate nightly sleep so that they can obtain sufficient amounts, at least in situations where they are able to exert control over their own sleep/wake schedules.

The most important questions in this survey dealt with whether there was a perception that fatigue is a current problem in Army aviation. With regard to this issue, the answers to several items indicate that there is in fact some cause for concern. Seventy-two percent of the pilots in this study indicated they had, at some time, flown when they were so drowsy that they could have easily fallen asleep; and 45 percent of the aviators indicated that they had at some point "dosed off while flying/in the cockpit." These findings suggest a fatigue problem in Army aviation that is similar to the one Rosekind et al. (2000) found in civilian commercial/executive flight operations. In the Rosekind et al. sample, nearly three-quarters of the pilots reported having "nodded off" during a flight. Rosekind et al. (2000) also reported that 85 percent of the participants in their study considered fatigue to be a moderate or serious safety issue. In the present sample of Army pilots, 81 percent said they thought fatigue was a factor in the recent increases in aviation accidents/incidents, and almost three-quarters felt fatigue was a widespread problem in the military aviation community. The responses from the nonaviators were similar.

Taken together, these results with regard to work and sleep habits, and those relating the perceptions of aviation crews about the issue of fatigue in Army aviation, suggest that continued emphasis on fatigue management is essential. The Army has consistently stressed the importance of proper crew scheduling and crew rest as is indicated by the presence of the crew-endurance guideline in Army Regulation (AR) 95-1 (1991). However, the findings reported here suggest that on an organizational level, problems may remain with regard to ensuring quality sleep in field/deployment settings, and with regard to scheduling crews in ways that improve on-the-job alertness by maximizing the quality of off-duty sleep. On an individual level, problems appear to exist with regard to personnel setting aside a sufficient amount of time every day to ensure they receive the 8 hours of restorative sleep required to ensure maximum performance. Of course, the 24-hour-per-day nature of Army aviation, combined with the lack of predictability associated with operational flight needs, will continue to make effective fatigue management difficult, but a focused educational program that includes both commanders and individual soldiers will go a long way toward minimizing sleepiness on the flight line and in the cockpit.

References

- Army Safety Center. 2000. Fatigue-related Army aviation mishaps, personal communication with Ms. Reta Dyson at helpdesk@safetycenter.army.mil. Fort Rucker, AL: U.S. Army Safety Center.
- Battelle Memorial Institute. 1998. An overview of the scientific literature concerning fatigue, sleep, and the circadian cycle. Allied Pilots Association.
www.alliedpilots.org/pub/presskit/safety/battellereport.html.
- Balkin, T., Thorne, D, Sing, H., Thomas, M., Redmond, D., Wesensten, N., Williams, J., Hall, S., and Belenky, G. 2000. Effects of sleep schedules on commercial motor vehicle driver performance. Washington, DC: Department of Transportation. DOT Technical Report No. DOT-MC-00-133.
- Brown, M. B. 1990. BMDP4F Forming frequency tables, in Dixon, W. J., Brown, M. B., Engelman, L., and Jennrich, R. I. (Eds.) BMDP Statistical Software Manual, Vol. 1, pp 231-274. Berkeley: University of California Press.
- Caldwell, J. L, and Cornum, R. L. S. 1992. Documentation of activity and rest of a U. S. National Guard attack helicopter battalion. Aviation, space, and environmental medicine. 63:925-929.
- Committee on Transportation and Infrastructure. 1999. Pilot fatigue. Hearing of the Committee on Transportation and Infrastructure, Subcommittee on Aviation.
www.house.gov/transportation/aviation/08-03-99memo.html.
- Comperatore, C. A., Liberman, R. R., Kirby, A. W., Adams, B., and Crowley, J. S. 1996. Melatonin efficacy in aviation missions requiring rapid deployment and night operations. Aviation, space, and environmental medicine. 67(6):520-524.
- Department of the Army. 1997. Aviation Flight Regulations, Crew Endurance. Washington, DC: Headquarters, Department of the Army. Army Regulation 95-1, pp 9-10.
- Dinges, D. F. 1995. An overview of sleepiness and accidents. Journal of sleep research. 4(suppl 2): 4-14.
- Dinges, D. F., Graeber, R. C., Rosekind, M. R., Samel, A., and Wegmann, H. M. 1996. Principles and guidelines for duty and rest scheduling in commercial aviation. Moffett Field, CA: Ames Research Center, National Aeronautics and Space Administration. NASA Technical Memorandum No. 11040.

- Dixon, W. J., Sampson, P., and Mundle, P. 1990. BMDP7D One- and two-way analysis of variance with data screening, in Dixon, W. J., Brown, M. B., Engelman, L., and Jennrich, R. I. (Eds.) BMDP Statistical Software Manual, Vol. 1, pp 189-212. Berkeley: University of California Press.
- Engelman, L. 1990. BMPD2D Detailed data description including frequencies, in Dixon, W. J., Brown, M. B., Engelman, L., and Jennrich, R. I. (Eds.) BMDP Statistical Software Manual, Vol. 1, pp 135-144. Berkeley: University of California Press.
- Federal Aviation Regulations. 2000. Part 121: Operating requirements: Domestic, flag, and supplemental operations, Federal Aviation Regulations, Title 14 Code of Federal Regulations, Ch. I and III. Washington, DC: Federal Aviation Administration. (www.faa.gov/avr/afs/fars).
- Hebert, H. J. 1999. Pilot error: Fatigue, confusion cited in '97 Korea Air crash. The Associated Press, www.abcnews.go.com/sections/world/DailyNews/koreacrash991102.html.
- Krause, K. S. 1999. Little Rock aftermath. Trafficworld, June: 11-12.
- National Sleep Foundation. 1999. Omnibus "Sleep in America" poll. Washington, DC: National Sleep Foundation.
- National Sleep Foundation. 1997. Sleeplessness, pain and the workplace. New York: Louis Harris and Associates, Inc.
- National Transportation Safety Board. 1997. Cockpit voice recorder transcript, Korean Air flight 801, DCA97MA058. Washington, DC: National Transportation Safety Board.
- NASA. 2000. NASA Statement on Pilot Fatigue. Hearing of the Aviation Subcommittee of the Committee on Transportation and Infrastructure, U.S. House of Representatives. www.hq.nasa.gov/office/legaff/mann8-3.html.
- Department of Labor. 1999. 1999 Report on the American workforce, pp. 80-84. Washington DC: U.S. Department of Labor.
- Ramsey, C. S., and McGlohn, S. E. 1997. Zolpidem as a fatigue countermeasure. Aviation, space, and environmental medicine. 68(10): 926-931.
- Ritter, R. D. 1993. "And we were tired:" Fatigue and aircrew errors. IEEE AES systems magazine. (March) 21-26.
- Rosekind, M. R., Co, E. L., Gregory, K. B., Miller, D. L. 2000. Crew factors in flight operations XIII: A survey of fatigue factors in corporate/executive aviation operations. Moffet Field,

CA: National Aeronautics and Space Administration. NASA/ATM Technical Report 2000-209610.

Rosekind, M. R., Co, E. L., Gregory, K. B., Miller, D. L., and Neri, D. F. 1997. A survey of fatigue factors in corporate/executive aviation operations. Sleep research. 26:213.

Rosekind, M. R., Gander, P. H., Miller, D. L., Gregory, K. B., Smith, R. M., Welson, K. J., Co, E. L., McNally, K. L., and Lebacqz, J. V. 1994. Fatigue in operational settings: Examples from the aviation environment. Human factors. 36(2):327-338.